HYCOM & Navy Ocean Prediction

John Harding
Naval Oceanographic Office

Harley Hurlburt
Naval Research Laboratory

8th Hybrid Coordinate Ocean Model Workshop
August 19-21, 2003

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE **AUG 2003**	2. REPORT TYPE	3. DATES COVERED **00-00-2003 to 00-00-2003**

4. TITLE AND SUBTITLE **HYCOM & Navy Ocean Prediction**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Research Laboratory,Stennis Space Center,MS,39529**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**12**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

HYCOM & Navy Ocean Prediction
Role of Ocean Modeling

Important (Not Sole) Tool for the Operational Oceanographer Providing Oceanographic Environmental Intelligence Relevant to the Warfighter
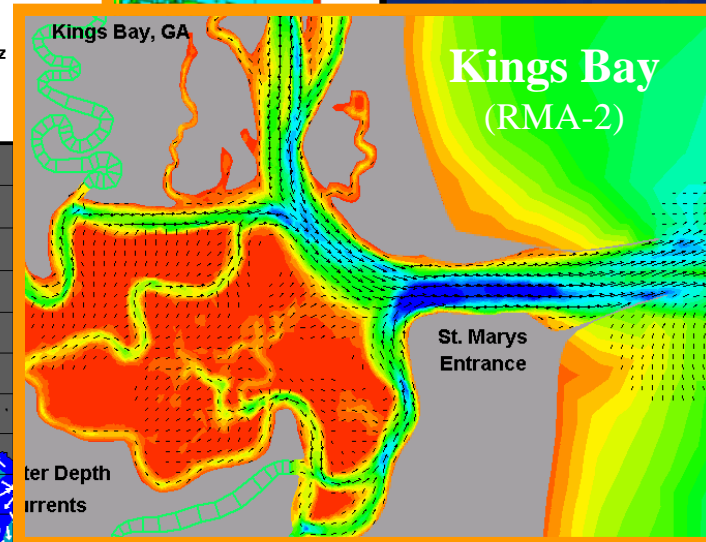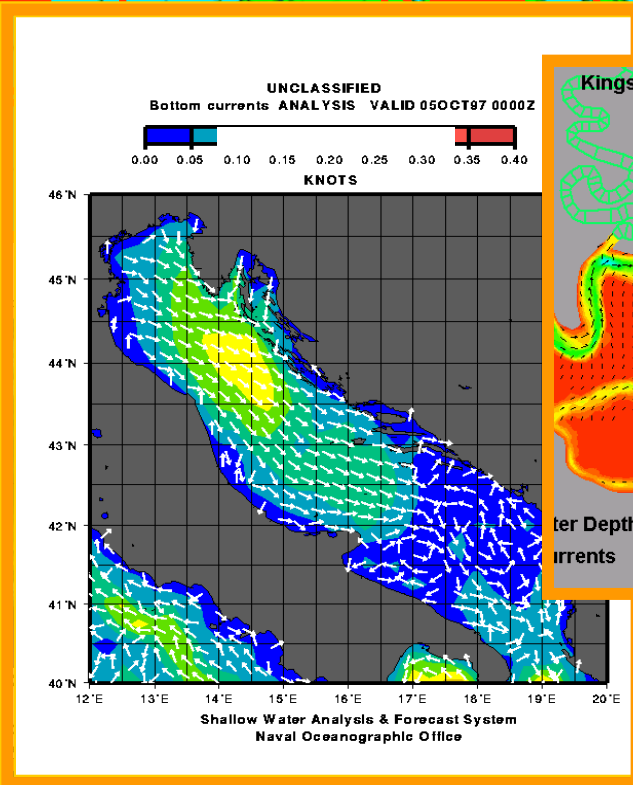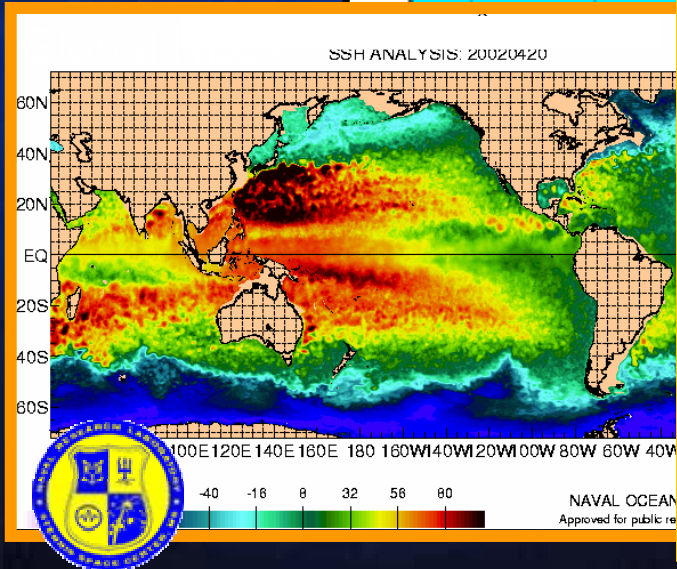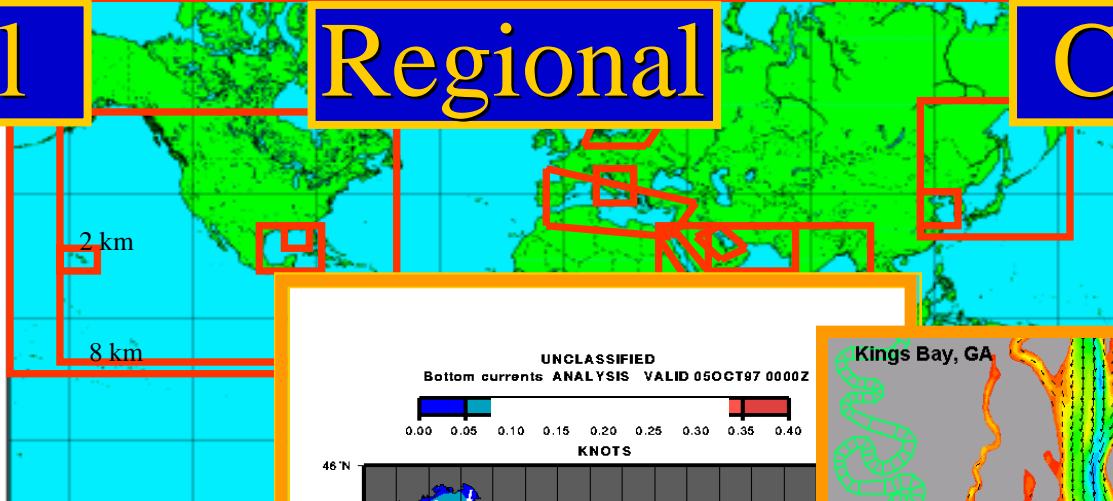
HYCOM & Navy Ocean Prediction
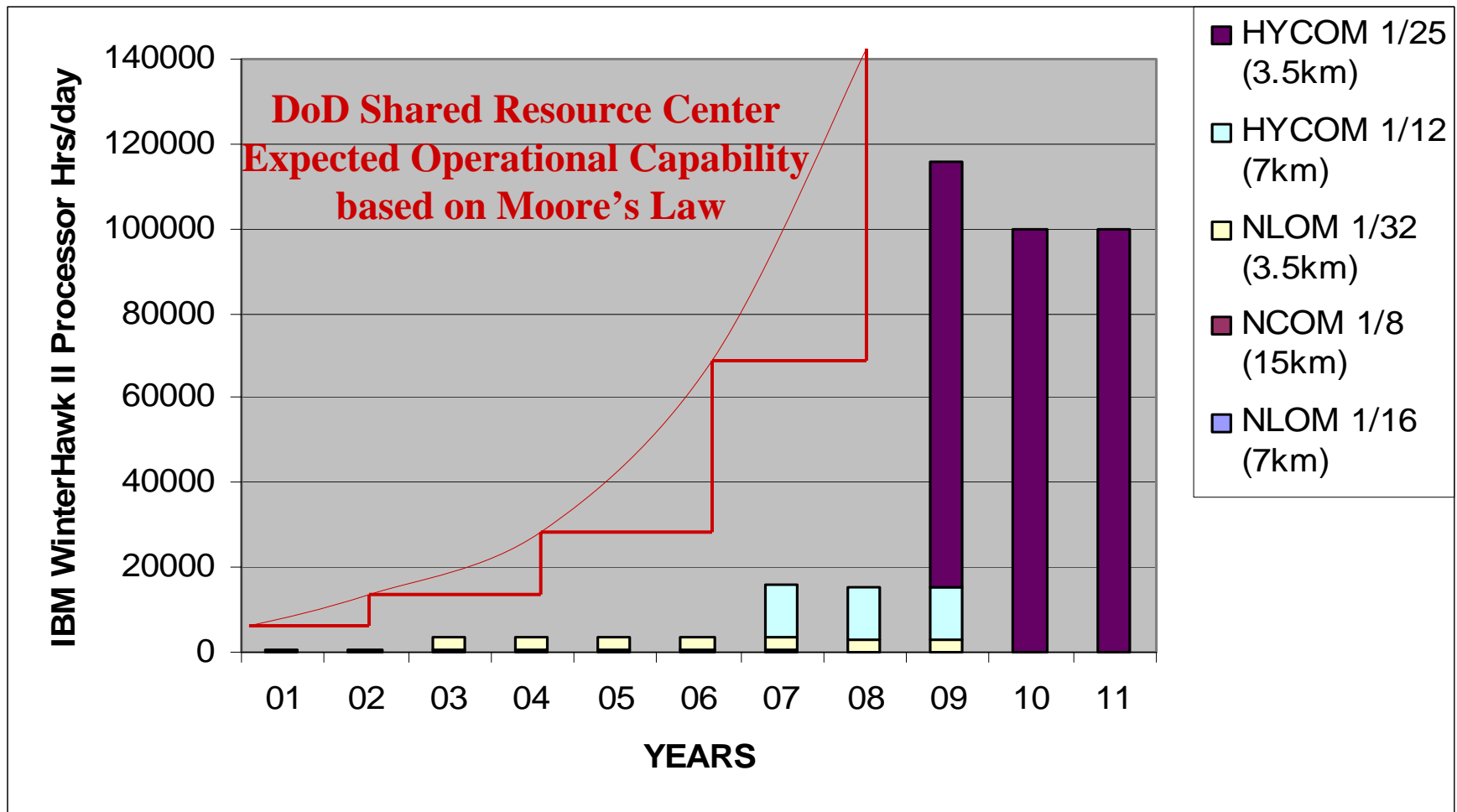## Nested Approach & Focus on the Littoral

Global

Regional

Coastal

2 km

8 km

SSH ANALYSIS: 20020420

60N 40N 20N EQ 20S 40S 60S

100E 120E 140E 160E 180 160W 140W 120W 100W 80W 60W 40W

-40 -16 8 32 56 80

NAVAL OCEAN
Approved for public re

UNCLASSIFIED
Bottom currents ANALYSIS VALID 05OCT97 0000Z

0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
KNOTS

46°N
45°N
44°N
43°N
42°N
41°N
40°N

12°E 13°E 14°E 15°E 16°E 17°E 18°E 19°E 20°E

ter Depth
rrents

Shallow Water Analysis & Forecast System
Naval Oceanographic Office

Kings Bay, GA

Kings Bay
(RMA-2)

St. Marys
Entrance

HYCOM & Navy Ocean Prediction
Computing Resources – Critical Role of the NAVO MSRC (Global Example)

DoD Shared Resource Center Expected Operational Capability based on Moore's Law

Legend:
- HYCOM 1/25 (3.5km)
- HYCOM 1/12 (7km)
- NLOM 1/32 (3.5km)
- NCOM 1/8 (15km)
- NLOM 1/16 (7km)

Y-axis: IBM WinterHawk II Processor Hrs/day (0 – 140000)

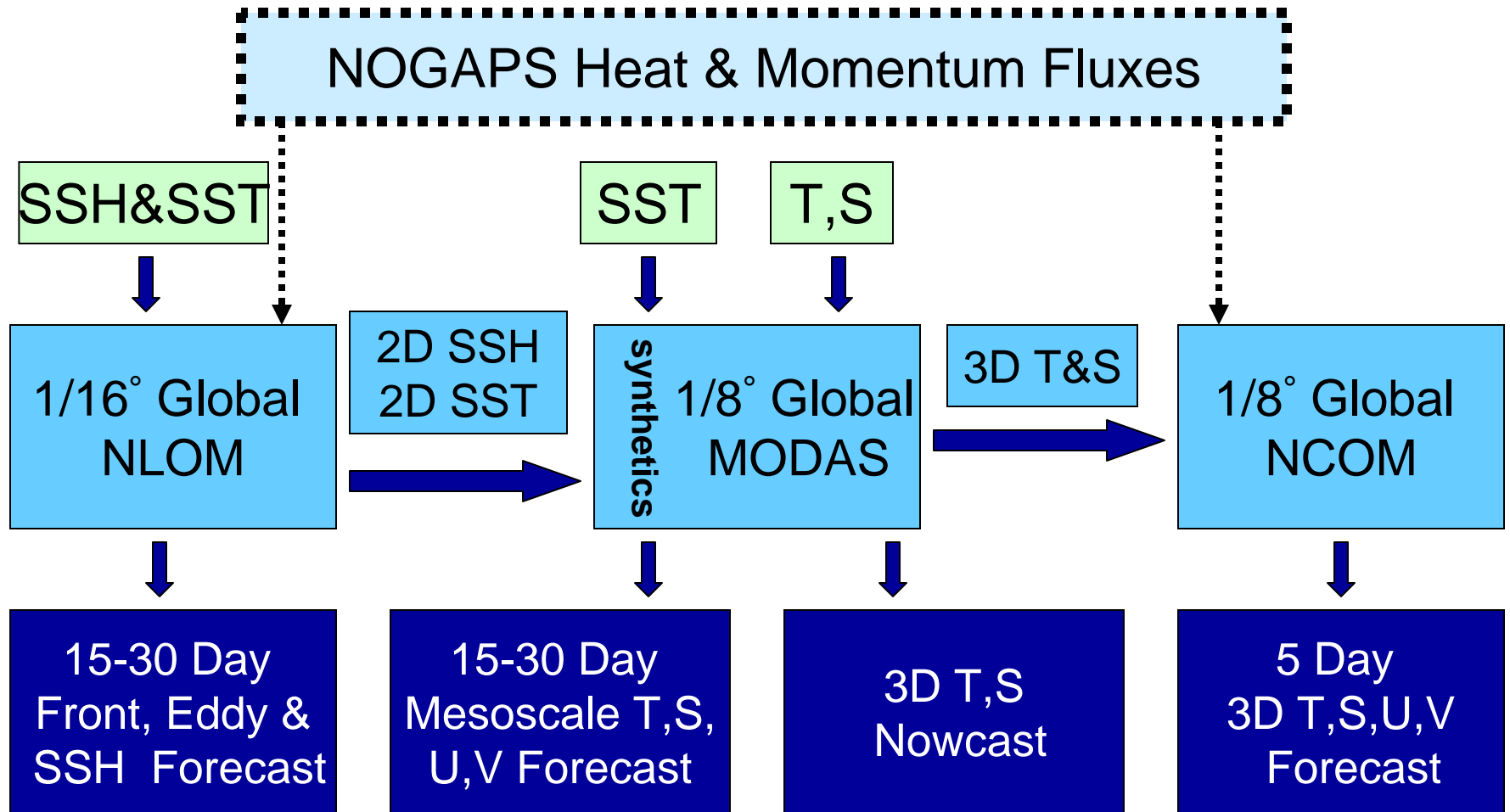X-axis: YEARS (01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11)

While much of the ocean's mesoscale variability can be forecast, routine global forecasts (at 1/32 degree resolution) remain a Grand Challenge computational goal potentially achievable in 2009 with current level of expenditure.

HYCOM & Navy Ocean Prediction

Near-Term Global Baseline Prediction System

HYCOM & Navy Ocean Prediction
Nesting Strategy for Ocean Prediction

Global	→	Regional	→	Littoral	→	Nearshore

***Near-Term:* present-FY04 in <u>R&D</u>, FY03-FY06 <u>operational</u>, including transition**

1/8° NCOM	→	SWAFS & NCOM	→	SWAFS & NCOM	→	**RMA2/ADCIRC
15-16 km mid-lat resolution	→	4 - 8 km, larger regions	→	< 1 to 2 km res	→	< 2 km resolution finite element

***Mid-Term:* FY04 - FY07 in <u>R&D</u>, FY06 – FY10 <u>operational</u>, including transition**

1/12° HYCOM	→	*SWAFS/NCOM/ HYCOM	→	*SWAFS/NCOM / HYCOM	→	**ADCIRC
7 km mid-lat resolution	→	2 - 4 km, smaller regions	→	.5-1.5 km res	→	< 1.5 km res

***Long-Term:* FY07-FY10 in <u>R&D</u>, FY10 and beyond <u>operational</u>, including transition**

+1/25° HYCOM	→	Regional generally not needed	→	*NCOM/HYCOM	→	**ADCIRC
3 - 4 km mid-lat resolution	→	Not used	→	≤ 1km res	→	≤ 1 km res

*Hogan and Kindle CO-NESTS project should provide research results needed to make the appropriate choice. An alternative model such as ROMS may also be considered.
+1/25° HYCOM gives useful littoral resolution globally.
**Nearshore models need a robust baroclinic capability before they can fully fill this role.

HYCOM & Navy Ocean Prediction
Planned Operational Transitions

Global Product	Vert. Coord.	Inputs	Run By	Target Date (Operations)
1/8° NCOM [1]	σ/z	SSH, SST, hydro, FNMOC atmospheric forcing	NAVO	2003
1/32° NLOM	Layered		NAVO	2003
1/12° HYCOM [2]	ρ/σ/z		NAVO	2007
1/25° HYCOM	ρ/σ/z		NAVO	2010

[1] High vertical resolution for mixed layer prediction. Assimilates SSH from NLOM. Running in real-time, see http://www.ocean.nrlssc.navy.mil/global_ncom

[2] 1/12° Atlantic and coarser global HYCOM are GODAE-related pilot projects under the National Ocean Partnership Program (NOPP). 1/12° Atlantic HYCOM demo is running in near real-time. Results at:

http://hycom.rsmas.miami.edu/ocean_prediction.html

HYCOM & Navy Ocean Prediction
A Validation Baseline for Operational Ocean Prediction – NCOM G8

Model experiments to be tested
- Free running 1998-2001
- Assimilative 1998-2003
- Bimonthly 7-day forecasts 1998-2002

Validation Tests (vs. Unassimilated Data)
- Sea Surface Height (analysis vs. sea level data)
- Sea Surface Temperature (analysis/forecast vs. MCSSTs & buoys)
- Mixed Layer Depth (analysis vs. profile data)
- Large-scale, meso-scale circulation features (mean, analysis position)
- Eddy kinetic energy/SSH variability (means)
- Current cross sections (events, means)
- Comparison with drifting buoys (June, 2000 – Nov.,2000)
- 3D profiles and vertical cross sections (analysis vs. profile data)
- Transport through straits (total, means)
- Regional evaluations by collaborators

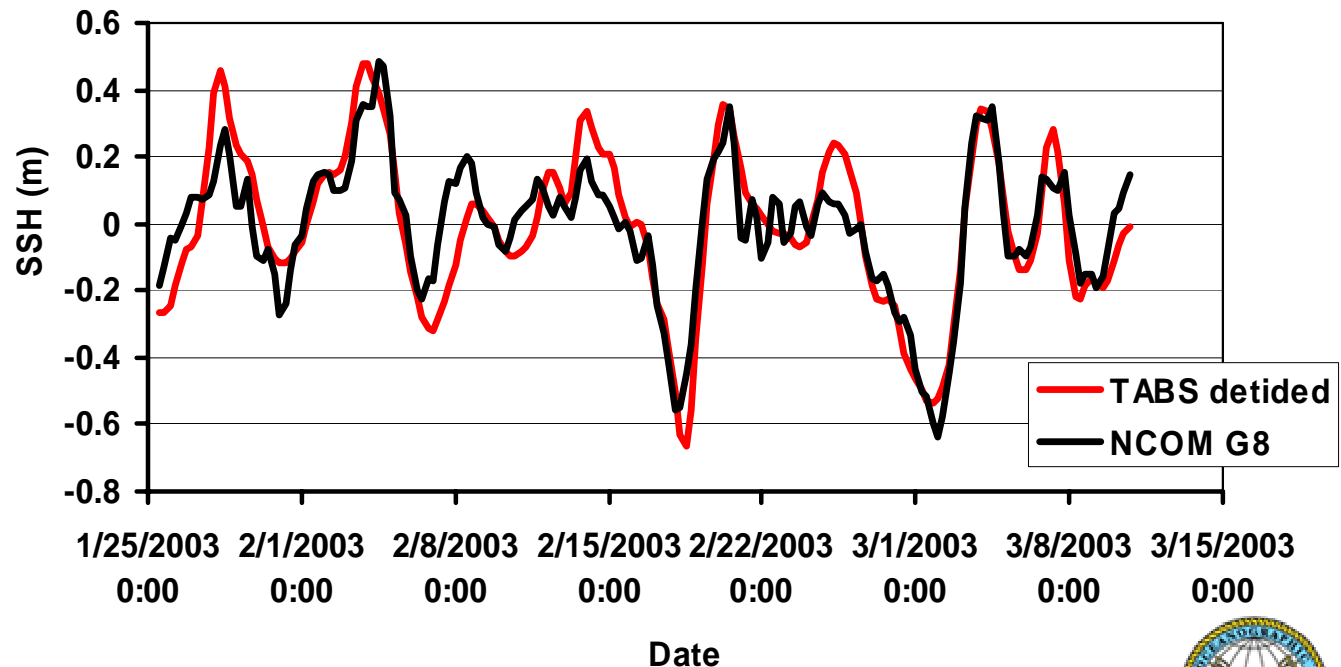# HYCOM & Navy Ocean Prediction
Persian Gulf SSH Validation of NCOM G8 relative to Buoy

A U.S. Navy buoy deployed in late January 2003 measured sea level in northwestern Persian Gulf until damaged in mid-March. Comparisons of the detided buoy observations with the independent NCOM G8 model results referenced to the same mean demonstrates the accuracy of the model predictions.

Surface Currents over Height (cr
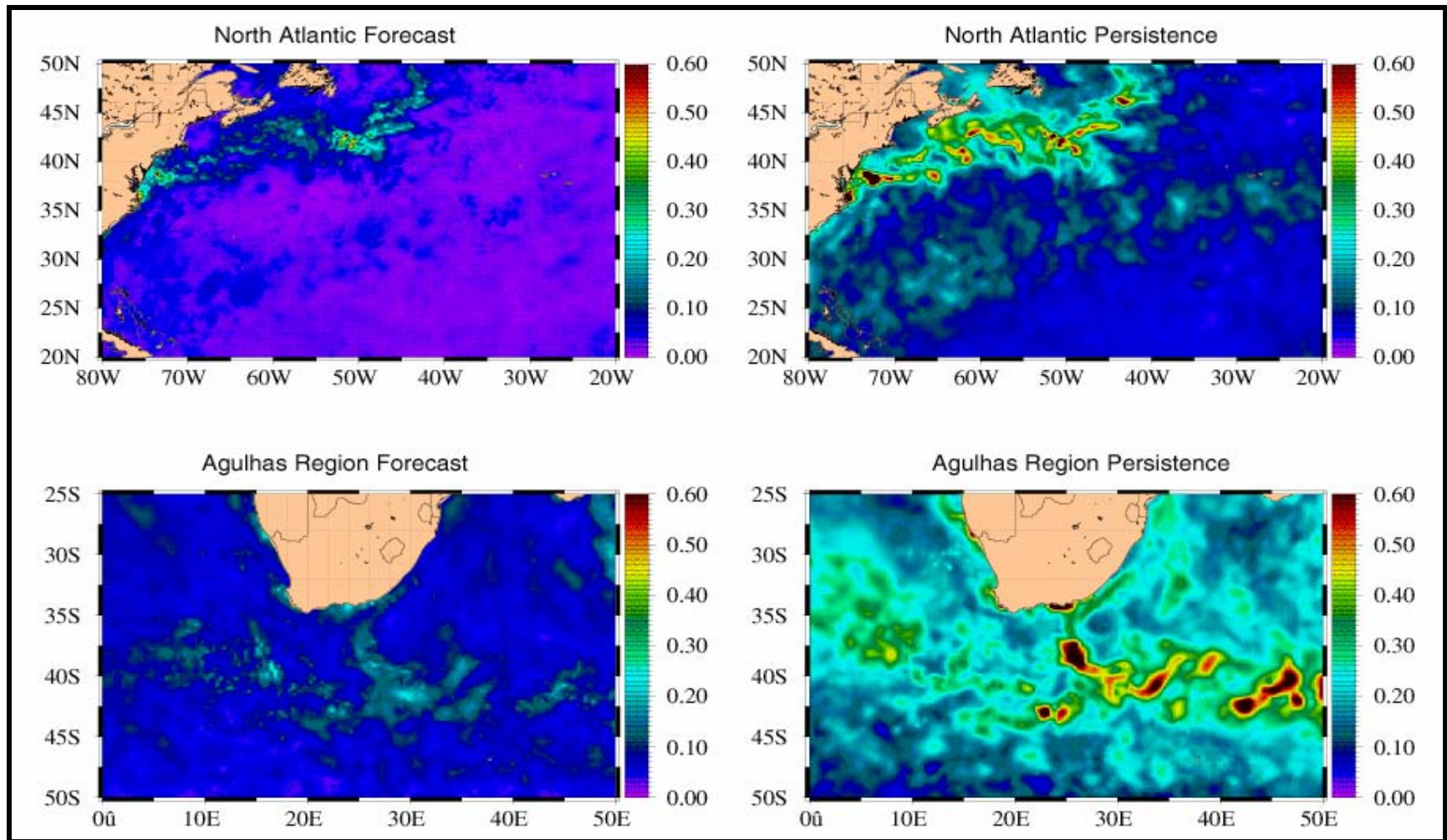NRL global NCOM nowcast
04-07-2003 00Z analysis

Velocity Scale: 100 cm/s
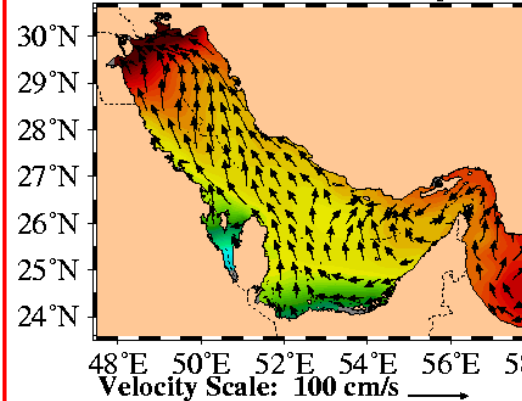
NCOM G8 vs detided TABS SSH in Persian Gulf sampled at 6 hours correlation 0.89

SSH (m)

Date

TABS detided
NCOM G8

HYCOM & Navy Ocean Prediction

NCOM 48 hr. SST Forecast Verification – (Relevant to Coupled Air/Ocean)

2 Day SST Forecast Verification Statistics

Mean RMS (⁰C) over 40 forecasts made 4 Jan 2001 – 12 Feb 2001

HYCOM & Navy Ocean Prediction
Summary of Planned Long-Term Operational Capability

- **.08° fully – global ocean prediction system transitioned to NAVO in 2006 (Expected Operational 2007)**
  - ♦ ~7 km mid-latitude resolution
  - ♦ Include shallow water, minimum depth 10 m (or less)
  - ♦ Bi-polar (PanAm) grid for Arctic
  - ♦ FY05-07 DoD HPC Challenge project essential
  - ♦ Embedded ice model
  - ♦ Account for Tides (internal or external to HYCOM)
  - ♦ General Nesting Capability (Regional SWAFS/NCOM/HYCOM)

- **Increase to .04° resolution globally and transition to NAVO by the end of the decade**
  - ♦ ~3.5 km mid-latitude resolution
  - ♦ Good resolution for coastal model boundary conditions globally
  - ♦ "Baseline" resolution for shelf regions globally